UNITED STATES GOVERNMENT

MEMORANDUM

ORIGINAL
FILE

DATE: July 13, 1992

REPLY TO ATTN OF: B. C. "Jay" Jackson, Jr.
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Mobile Services Division, CCB

SUBJECT: CC Docket 92-115; Revision of Part 22 of the Commission's rules governing the Public Mobile Services

TO: Chief, Dockets Branch
Office of the Secretary, OMD

In the Notice of Proposed Rule Making in the subject docket, the Commission proposes to require general aviation air-ground systems to comply with the technical and operational specifications contained in the document titled "Technical Reference, Air-ground Radiotelephone Automated Service (AGRAS), System Operation and Equipment Characteristics" and dated April 12, 1985 (Appendices A and B, proposed § 22.819).

Attached are three copies of this document. Please insert a copy this document in the original and duplicate docket binders (and RIPS if possible) so that interested members of the public may refer to it when preparing comments or replies (comments due August 21, 1992; replies due September 21, 1992). Thank you.

TECHNICAL REFERENCE
AIR-GROUND RADIOTELEPHONE AUTOMATED SERVICE
(AGRAS)
SYSTEM OPERATION AND EQUIPMENT CHARACTERISTICS

REF: 650-0244-000 WCT-100 Minimum Performance Specification

PART NUMBER	DESCRIPTION	ITEM
← DASH NO.	PART NUMBER SCHEDULE	

REV	C.O. Number	DATE
I	2732	7-30-85
H	RELEASE	4-12-85
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WULFSBERG ELECTRONICS, INC.
unit of Sundstrand Corporation
11300 WEST 89TH STREET
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SCALE

Tolerance Unless Noted;
.XX ±.01 Fractions ±1/64
.XXX ±.005 Angles ± 1/2°

DRAWN BY: KJC
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ENG MGMT (E.E.): KJC

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1.0 INTRODUCTION

1.1 BACKGROUND

Public air-ground radiotelephone service was authorized originally under Part 21 of the commissions rules covering Domestic Public Radio Services. Regulation of the service currently resides in Part 22 of the rules (Public Mobile Radio Service). The service is comprised of two-way public radiotelephone communication between properly equipped aircraft and ground stations interconnected with the Public Switched Telecommunications Network (PSTN). The existing service is manual in nature requiring operator assistance and intervention in handling all calls. The present system accommodates "half duplex" push-to-talk (PTT) along with "full duplex" operation.

The ground stations may be provided by either wireline or non-wireline common carriers (RCC's). The aircraft radio equipment is provided and maintained by the customer. A telephone call origination from the aircraft is placed by manually selecting an idle channel from the 12 working channels and then keying the transmitter to alert the mobile operator. All call information is transferred by voice to the mobile operator. Upcalls are accommodated by a slow (6-12 second) two-tone signalling method on the control channel.

For more complete background of the existing system the reader is directed to the ATT Technical Reference, "Air-Ground Radiotelephone Service-Notes Covering System Operation and Aircraft Equipment Characteristics", dated December 1970.

1.2 THE AUTOMATED SYSTEM

The system characterized in this document will provide a fast transparent means of placing a phone call from a aircraft to the ground network. Upcalls will be equally easily facilitated. At its highest level of implementation, channel selection in the aircraft will be automatic, providing the caller with the best idle channel. Dialling will be done by push button in a manner that is universally familiar to a telephone user today.

1.3 SYSTEM IMPLEMENTATION

The Air-Ground Radiotelephone Automated Service (AGRAS) has been planned and designed to be compatible with the present manual service. The two types of service may co-exist. It is assumed that all manual ground terminals will eventually be replaced by automatic terminals capable of bi-mode (manual and automatic) operation and airborne units will either be modified, remanufactured, or replaced to provide the new automatic service.

1.4 SYSTEM LAYOUT AND EXTENDED RANGE

There is no change in the location of frequency assignments of the ground stations in the system to provide automated direct dial service. The improved service will become available from a given geographic location when the owner of such station chooses to upgrade the class of service offered to its customers.

It is recognized that since the time when the system layout was designed, with co-channel protection for aircraft flying to 40,000 feet, new aircraft have been designed to fly regularly in excess of 50,000 feet. The

possibility of co-channel interference exists due to this extended service range. Also co-channel interference may exist due to an RF propagation anomaly called ducting. A means of station identification and control signalling has been employed in the automated version to minimize the co-channel problem, if and when it exists.

1.5 CHANNEL PLAN

The channel plan to include the automated direct-dial system is basically unchanged from the existing plan with one exception. A review of Table 1 will shown the addition of one frequency, 459.675 MHz, to the list of those channels presently in service, air-to-ground. This frequency paired with 454.675 MHz becomes the duplex channel for control signalling. Ground-to-air two-tone signalling, presently in use, will continue to be provided for as long as necessary on 454.675 MHz.

CHANNEL #	FUNCTION	TRANSMIT FREQUENCIES	
		GROUND STATION	AIRCRAFT STATION
-	C	454.675 MHz	459.675 MHz
6	W	.700	.700
7	W	.725	.725
5	W	.750	.750
8	W	.775	.775
4	W	.800	.800
9	W	.825	.825
3	W	.850	.850
10	W	.875	.875
2	W	.900	.900
11	W	.925	.925
1	W	.950	.950
12	W	.975	.975

W = Working Channel
C = Control Channel

TABLE 1. AIR-GROUND RADIO TELEPHONE CHANNEL PLAN

1.6 SYSTEM FEATURES

The Air-Ground Radiotelephone Automated Service (AGRAS) is designed primarily to facilitate call placement, both air-to-ground and ground-to-air. At the highest level of complexity allowed for by this specification, the radio link and terminal operation is transparent to the user. The airborne phone is as straight forward to use as any normal subscriber instrument, but with many additional features for the more sophisticated user.

Features, fixed by this specification include:

1) Air-to-Ground Direct Dialling
2) Ground-to-Air Direct Dialling
3) Queueing (Camp-on)
4) Busy Channel Muting (Privacy)
5) Full Duplex Only

Features provided for, but not fully defined by this specification, that are add-on in nature are:

1) Flight Following Service
2) Networked Upcall Service
3) Paging Service
4) Voice Message Retrieval Service
5) Data Network Connection Service
6) Others (yet undefined)

Placement of a call to a busy ground station channel is made possible by a queueing action (camp-on). This feature will automatically complete the attempted call when the channel becomes available. Using this feature, optimization of call traffic can be accomplished by multiple channel ground

stations and service may be improved thus minimizing the waiting time in queue. The control of queueing is managed at the ground station. Upcalling can be accomplished through a ground station by means of direct dialling to the ground station and DTMF end-to-end signalling,[1] to the aircraft. The caller must know the general location of the aircraft being called and the ground stations nearby to the aircraft. It is to the benefit of the ground station licensee to make available the telephone number of each ground station to the AGRAS user.

1.6.1 ADD-ON FEATURES AND FUTURE EXPANSION

This system specification makes provision for additional features by virtue of the ability of each aircraft to establish and maintain a link with a selected ground station. This link may be determined at the aircraft simply by a determination of the best signal path or by a more sophisticated computation of position relative to the received ground station in the case of aircraft utilizing area navigation based on global coordinates. (Take note from Table 2. that the ground station identifies itself uniquely in terms of channel number and coordinate position.) The link thus established is used for the signalling and communications necessary to provide the additional features.

2.0 AGRAS SYSTEM OPERATION

A system is comprised of a number of aircraft in any given ground station extended service range and a number of ground stations in any given aircraft extended service range. (See Section 1.4 for an explanation of the term "extended service range".)

[1]See Bell Systems PUB43303

For the purposes of telephone call interconnection, each ground station is connected to the PSTN and may or may not be directly interconnected one with another.

An idle Aircraft Radio Unit (ARU) shall monitor the control channel to receive any message directed at that aircraft, and in addition, determine from messages directed at other aircraft (including periodic broadcast messages (BCST) from ground stations) the best channel to select when a caller takes the ARU "off-hook". If the ARU is unable to determine a useful channel by this means, then it may scan the working channels after being taken "off-hook" and prior to call signalling.

When placing a call from an aircraft, the ARU is connected to the selected ground station by means of a sequence of digital messages in the control channel between air and ground. Call processing proceeds with the switching of the airborne unit and the ground station to the working channel and the ground station terminal completing the dialling of the number received and held in storage. This process is completed automatically without human intervention.

Should the ARU attempt a call with a busy ground station (this is possible due to a user directed choice of channels or all useful channels busy) the ground station will return a control message putting the ARU in queue. The caller may accept this action or attempt a call on another channel of his selection, at which time the previous queue arrangement will be automatically broken by the appropriate control message to the ground station that arranged the queue.

Telephone call completion from the ground station to aircraft is accomplished by the ground station transmitting the appropriate control message carrying the Aircraft Mobile Identification Number (AMIN) and providing a ringing tone to the caller. Upon recognition of this message the ARU returns a control channel message indicating that it is ringing. A tone is sent in the working channel with an "off-hook" condition and the ground station connects the calling party to the working channel. A disconnect tone sequence is sent in the working channel by the ARU upon completion of the call.

Aircraft Radiotelephone Units (ARUs) using any of the add-on features (See Paragraph 1.6) will periodically transmit a control message to its choice of ground station that provides the service subscribed to. The ground station will reply with an acknowledgement to the ARU, and in turn, update, over the wireline network, the particular services' data base with the latest aircraft report. A service up-call may then be initiated and completed through the last ground station reported to have been in communication with the ARU.

Airborne equipment designed according to this specification will be able to interface with the data service supplier and carry data between data network nodes; one node being the aircraft, the other at the ground station. Dispersal or gathering of this data at the ground station node is accomplished according to arrangements between the ground station licensee and the supplier of the data service. The actual data exchange in the working channel is setup as a phone call by an exchange of control messages in the control channel.

3.0 TECHNICAL CHARACTERISTICS

This specification defines the technical characteristics required for equipment manufactured and intended for use in the Automated Air-Ground Radiotelephone System, as well as equipment intended to co-exist with the manual system currently in operation. It should also be understood that this system specification does not preclude existing manual equipment (both airborne and ground station) from being adapted or upgraded to operate in the automated system. It is generally recognized that there may be some technical specifications that can not be economically satisfied and yet may provide slightly degraded but satisfactory service. This specification should be used as a reference and performance goal when up-grading existing equipment.

3.1 AIRBORNE TRANSMITTER CHARACTERISTICS

3.1.1 CHANNELS

The airborne transmitter shall be capable of transmitting on any one of the thirteen channels shown in Table 1.

3.1.1.1 FREQUENCY TOLERANCE

The departure of the transmitter frequency from the assigned channel frequency shall be less than $\pm 0.00025\%$ for all environmental conditions including an ambient temperature range of -30 to +60 degrees C.

3.1.1.2 CHANNELING SETTLING TIME

The time from the instant of decoding a command to change channels, to the instant the ARU channel stabilizing element stays within 0.25 kHz of the stabilized operating frequency shall be less than 150 milliseconds. The transmitter may not be keyed on during this interval.

3.1.2 AIRBORNE TRANSMITTER POWER OUTPUT

The airborne transmitter shall have an output power of less than 25 Watts but more than 4 Watts. The power shall not fall below 4 Watts at environmental temperature extremes.

3.1.2.1 HARMONICS AND SPURIOUS

Transmitter harmonics and spurious shall be attenuated greater than (43 + $\log_{10} P_{mean}$) dB below the main carrier level. (See the Commission's rules, Part 22, Paragraph 106.)

3.1.2.2 TRANSMITTER POWER OUTPUT SETTLING TIME

The transmitter power output shall be within 3 dB of full output power within 20 milliseconds of a transmitter turn-on command, following the channel settling time.

3.1.2.2.1 TRANSMITTER OUTPUT SEQUENCE (CONTROL CHANNEL)

The transmitter shall be turned on and modulated with a "0" data signal in phase with the message to follow, for 150 milliseconds prior to the transmission of the downlink data message. This interval of transmitted and modulated signal is necessary to overcome the effects of squelch delay in the base station receiver and remote signalling delay between the base station receiver and the terminal. The transmitter shall remain on, unmodulated for 10-30ms after the downlink data message. (See Fig. 1, Appendix I)

3.1.2.3 POWER TRACKING

Power output variation over the operating channels shall be less than 1 dB total.

3.1.2.4 TRANSMITTER POWER OFF

The carrier output in a transmitter off condition shall be less than -60 dBm. This level must be achieved in 20 milliseconds after removal of the keying signal.

3.1.3 MODULATION CHARACTERISTICS, AIRBORNE TRANSMITTER

The transmitter shall be FM modulated.

3.1.3.1 VOICE AND CONTROL SIGNALS

The modulator circuitry must accommodate the voice frequency spectrum of 300 to 3000 Hz. These audio signals are derived from microphone or handset sources and the control signalling modem and may include DTMF tones and digital signals through these interfaces from acoustic coupler devices, modems etc.

3.1.3.1.1 PRE-EMPHASIS

The pre-emphasis characteristic shall be nominally +6 dB per octave between 300 and 3000 Hz.

3.1.3.1.2 MODULATION LEVEL

The level of modulation of the transmitter should be as high as possible, consistent with keeping the loudest talker from producing excessive distortion. In general, average speech, as received on a companion receiver, should produce an audio output which is 6 dB below the value indicated on a VU meter for 1000 Hz non-limited modulation that provides two-thirds (2/3) of rated system deviation.

The level of the control channel signalling modulation shall be set such that the 2200 Hz tone produces at least $\pm$4.5 kHz deviation but not exceeding $\pm$5 kHz.

3.1.3.1.3 DEVIATION LIMITER

For voice audio inputs (handset or microphone) applied to the ARU, the audio signal processing stages must limit the instantaneous frequency deviation to ±5 kHz. (See the Commission's rules, Part 22, Paragraph 508(d).)

3.1.3.1.4 POST DEVIATION LIMITER FILTER

The post deviation limiter filter shall have a stop band characteristic as described in the Commission's rules, Part 22, Paragraph 508(g).

3.1.3.1.5 AIRBORNE TRANSMITTER DISTORTION, VOICE SIGNALS

A 1000 Hz test tone modulating the transmitter at a deviation of ±3.0 kHz shall result in less than 5.0% distortion.

3.1.3.2 DIGITAL SIGNALS (DATA PORT PROVISION)

Digital (data) signal inputs, band limited between 300 and 3000 Hz, may be used to FM modulate the airborne transmitter. Pre-emphasis is not used. Direct input from a data management unit is regarded as a digital input signal and treated according to this paragraph and subparagraphs.

3.1.3.2.1 MODULATION LEVEL

The level of modulation for data shall be ±4.0 kHz, ±0.25 kHz. Under no circumstances may instantaneous peak deviation exceed ±5.0 kHz.

3.1.3.2.2 AIRBORNE TRANSMITTER DISTORTION, DIGITAL (DATA) SIGNALS

A 1200 Hz test tone modulating the transmitter at a deviation of ±4.0 kHz shall result in less than 5.0% distortion.

3.1.3.2.3 DELETED

3.1.3.3 DTMF SIGNALS

DTMF tone pairs B, C, and D (See Appendix C) are generated in the ARU and used for control signalling on the working channel (See Section 4.0). These and all other DTMF tone pairs are transmitted with pre-emphasis (See Paragraph 3.1.3.1).

3.1.3.3.1 MODULATION LEVEL

DTMF tone modulation shall be adjusted such that the DTMF tone pair "#" (See Appendix C) produces ±3.75 kHz, ±0.25 kHz deviation.

3.1.3.3.2 DTMF TONE FREQUENCY TOLERANCE

The DTMF tone frequencies shall be within ±1% of the frequency standard.

3.1.3.3.3 DTMF SIGNAL DISTORTION

The DTMF tones shall be transmitted with less than 5% total harmonic distortion when the modulation level is adjusted according to Paragraph 3.1.3.3.1.

3.1.3.3.4 DEVIATION LIMITER

For DTMF tone inputs applied to the ARU, the audio signal processing stages must limit the instantaneous frequency deviation to ±5 kHz. (See the Commission's rules, Part 22, Paragraph 508(d).)

3.1.3.3.5 POST DEVIATION LIMITER FILTER

The post deviation limiter filter shall have a stop band characteristic as described in the Commission's rules, Part 22, Paragraph 508(g).

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3.1.3.4 AIRBORNE TRANSMITTER HUM AND NOISE

The FM hum and noise level shall be at least 40 dB below standard modulation when tested with a standard de-emphasized receiver utilizing a C-message filter.

3.1.3.5 NOISE CANCELLING MICROPHONE

A noise cancelling microphone is recommended as a general practice. A noise cancelling microphone is required when the transmitter is used to transmit voice from an environment where ambient acoustical noise is in excess of 95 dBa flat weighting. (See the Commission's rules, Part 22, Paragraph 521(d).)

3.1.3.6 AIRBORNE TRANSMITTER GROUP DELAY

The differential group delay from any audio input to modulated transmitter output shall be less than 100 microseconds when measured at 600 Hz and 2400 Hz.

3.2 AIRBORNE RECEIVER

3.2.1 CHANNELS

The airborne receiver shall be capable of receiving on any of the thirteen frequencies labeled "Ground Station", shown in Table 1. Except when moved to a working channel to connect a call, the airborne receiver shall be tuned to the control channel frequency.

3.2.2 SENSITIVITY

The RF sensitivity of the receiver with the transmitter keyed shall be equal to or better than -110 dBm for 12 SINAD when using an EIA standard test signal.

3.2.3 SELECTIVITY

Adjacent channel selectivity (±25 kHz) shall be better than 65 dB when measured using the EIA two tone test method. The passband of the receiver filter should be equal to or greater than ±6.5 kHz at the 6 dB points.

3.2.4 SPURIOUS RESPONSE

Image and spurious responses shall be better than 70 dB down.

3.2.5 DEMODULATION CHARACTERISTICS

3.2.5.1 VOICE AND CONTROL SIGNAL OUTPUT

The demodulated voice signal output shall provide for voice and control signals with a bandwidth of 300 Hz to 3000 Hz and shall be de-emphasized.

3.2.5.1.1 DE-EMPHASIS

The de-emphasis characteristic must have a nominal -6 dB per octave response between 300 and 3000 Hz.

3.2.5.1.2 DISTORTION

Audio output at full level applied to the proper load termination shall have less than 5% harmonic distortion when tested with a EIA standard test signal.

3.2.5.1.3 HUM AND NOISE

Audio output applied to the handset transducer shall have hum and noise at least 40 dB below a 1000 Hz tone with ±3.0 kHz deviation when measured using C-message filtering with the RF input set at a level of 1000 microvolts.

3.2.5.2 DIGITAL (DATA) SIGNALS

A separate port shall be provided from the demodulator (discriminator) for digital (data) signal use. The frequency response of this port is nominally flat from 300 to 3000 Hz.

3.2.5.2.1 DISTORTION

Audio output to a data signal user shall have less than 5% harmonic distortion when tested with a 1000 microvolt signal modulated with a 1200 Hz tone, at ±4.0 kHz deviation.

3.2.5.2.2 DELETED

3.2.5.2.3 SIGNAL DEGRADATION

A net frequency drift of ±2.5 kHz in the receiver equipment and test generator shall cause no more than a 3 dB increase in the RF input above a reference level to maintain the same bit error rate (BER) that produces 12 dB SINAD (standard test conditions) on frequency (zero network frequency error).

3.2.5.2.4 HUM AND NOISE

Audio output to a data signal user shall have hum and noise at least 30 dB down (flat audio), when tested with a 1000 microvolt RF input and referenced to standard data signalling modulation.

3.2.5.2.5 AUDIO OUTPUT SWITCHING

If the discriminator audio output to the audio user system is switched (i.e., signal level actuated squelch), the maximum time allowed for audio switching after application of the RF signal to the receiver shall be 20 milliseconds. The DC and AC transient effect of such switching should be minimized and in no instance should it persist to the detriment of data decoding for more than 5 msec after switch closure.

3.2.5.3 DATA ERROR RATE

The signalling data demodulator (modem) shall have a bit error rate of better than 7×10^{-3} at an RF input level that produces 12 dB SINAD on the voice audio connection. This test is conducted using an alternating series of 1's and 0's.

3.2.5.4 GROUP DELAY DISTORTION

Differential group delay when measured from RF input to any audio output shall be less than 100 microseconds over the frequency range of 600 Hz to 2400 Hz.

3.3 GROUND STATION

The ground station shall be either a Class I or Class II type as defined here. A Class I ground station shall have transmitters and receivers dedicated to the control channel and working channel(s). A Class II ground station may time share a transmitter between the control channel and a working channel. A ground station of either class type will be capable of the basic automatic direct dial radiotelephone function. The Class I type ground station shall be capable of providing queueing and the additional service features as defined in Paragraph 1.6.